Dosing hypochlorite solutions

Most systems for hypochlorite solution dosing comprise three major components :

- Solution preparation ;
- Flow control ;
- Application.

The concentration of the hypochlorite solution is not strictly controlled, so chlorine levels should be monitored at the point of use and adjustments made at the site of flow control. The preparation of solution is simple using sodium hydroxide, as sodium hydroxide is available as a solution which can be diluted to an appropriate concentration (two per cent available chlorine).

Calcium hypochlorite preparations, however, contain some inert material and it is important that the solution is prepared and allowed to settle, before the clear solution is decanted off for use.

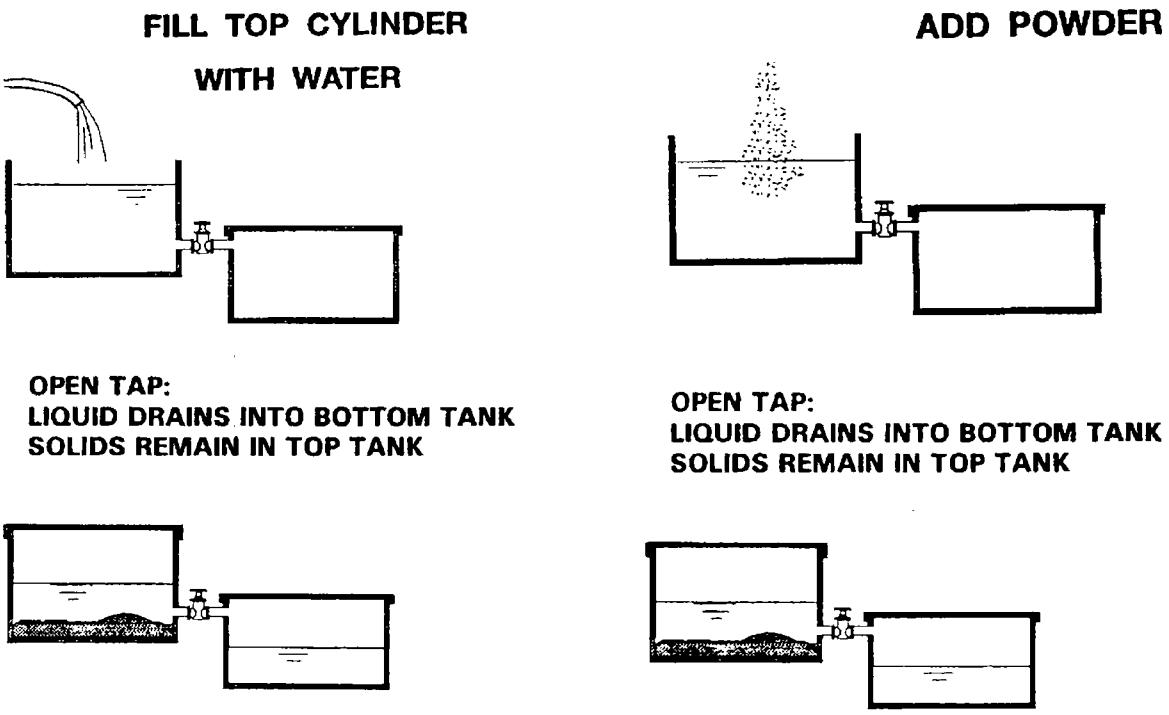

Figure 1. Preparation of calcium hypochlorite

Storage, handling and preparation of calcium hypochlorite is detailed in Fact Sheet 2.19 and of sodium hypochlorite in Fact Sheet 2.20.

Flow control mechanisms vary widely. Many may be constructed from readily available materials and are not costly. The most important types are described below.

Application of hypochlorite solutions should be at a point of turbulence to ensure adequate mixing. It should also be as early as possible in the supply system (except that chlorine should generally be added after other treatment and should never be added before slow sand filters) in order to ensure adequate contact time. Ideally, chlorinated water will flow into a contact tank, which will ensure a residence time of at least one hour, before the water enters the distribution network. In many small supplies this is provided by the storage tank or reservoir. However, this may be prone to short-cutting, especially if the inlet and outlet are positioned close to one another.

Operation and maintenance of dosing equipment

It is important to ensure regular monitoring of chlorine concentration after dosing, in piped distribution networks, and at distant points. Equipment should be adjusted as required and a record made of chlorine used. Results of monitoring and records of adjustments and repairs to equipment should be maintained.

Where solutions are made up from calcium hypochlorite powder, two tanks should be used (see Fact Sheet 2.19). The make-up tank, where the solution is mixed, should be cleaned regularly removing the white precipitate to prevent it being carried over into the next operation.

In general, the solution will be prepared in the make-up tank one day, left to settle overnight, and sedimented into the solution tank the next day. If this is not possible, the solution must be left for a minimum of one hour before decanting. The amount of solution in the solution tank should be checked regularly to ensure that solution can be made up when required. Generally, solution tanks hold sufficient hypochlorite to last a few days (often two to four days).

Where " dropping " equipment is used (for instance, drip-feed dosers), the dropping equipment should be regularly inspected for precipitates or blockages. Where pumps are used, they should be operated and maintained in accordance with the manufacturers' instructions.

It is important that all installations where chlorine is stored and handled are secure, especially against children. Site security should be periodically checked.

Drip-feed chlorinators

Drip-feed chlorinators are most used for small community water supplies. They feed a constant rate of drops of chlorine into the flow of water. The flow of water is assumed to be constant and therefore the chlorine dose will be constant.

If a pipe were connected to the chlorine tank and allowed to drip slowly directly into the flow of water, then the rate of drops would slow down as the level in the chlorine tank lowered. For this reason a constant head device is needed.

A simple constant head device is shown in Figure 2. The flow of chlorine solution out of the outlet tube is unrestricted ; what controls the rate is the depth of the inlet to the tube below the surface of the chlorine solution and this is constant no matter what the depth of chlorine solution in the tank. In order to prevent siphoning, the dosing pipe is open at both ends and should be of ample bore.

This type of system can be adjusted to supply as little as a few tens of litres per day. The solution outlet is the top of the tube leading into the floating bowl (see Figure 2).

By lowering the outlet the dosing rate is increased and by raising the outlet the dosing rate is decreased. The depth of the outlet below the surface of the chlorine solution may be adjusted by moving the tube up or down or by using weights, such as stones, to force the whole float to sit lower in the hypochlorite solution.

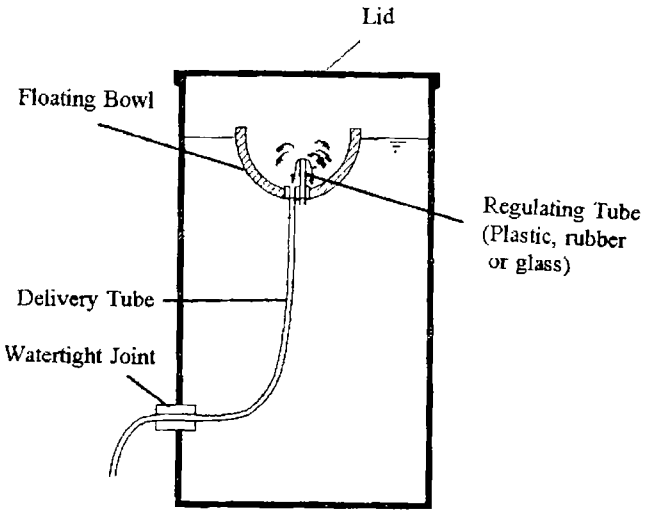

Figure 2. A constant head device for drip-feed chlorination

It is important to check hoses and tubes on drip-feed chlorinators regularly for blocking. They should be cleaned at regular intervals and replaced when necessary.

Constant-head aspirator (Mariotte Jar)

This is the simplest device for dosing hypochlorite solution and, given basic care, it can prove reliable in operation over many years.

The aspirator is fitted with a right-angled capillary outlet and a centre tube air inlet. When it is filled and solution drops from the capillary, air is drawn down the centre tube and bubbles up into the air space. The centre tube is full of air and is at atmospheric pressure at the base. Thus the head across the capillary is independent of the level in the aspirator, and can be altered (thus altering the drip rate) by rotating the capillary between horizontal and vertical positions.

Such a drip feeder can readily be assembled from standard laboratory glass-ware (the bottle must be rigid) and quickly installed. It requires minimal protection from the weather but must be kept completely dark. A 20-litre aspirator is a useful size for many situations, and is reasonably easily handled. The capillary bore most suitable for maintaining a trouble-free drip is 0.7-1.0 mm and the centre tube, preferably of medium to thick-walled glass, should have a diameter of 10-15 mm.

Coarse adjustment of drip rate is made by altering the height of the centre tube. For low flows (five drops per minute, or about one litre per day, is a practical minimum), it is preferable to have the capillary outlet less than 45o from the horizontal to preclude crystallization and subsequent blocking. Ten per cent sodium hypochlorite crystallizes only in the coldest weather. The equipment should ideally be installed in an insulated hut. Figure 3 shows a constant-head aspirator.

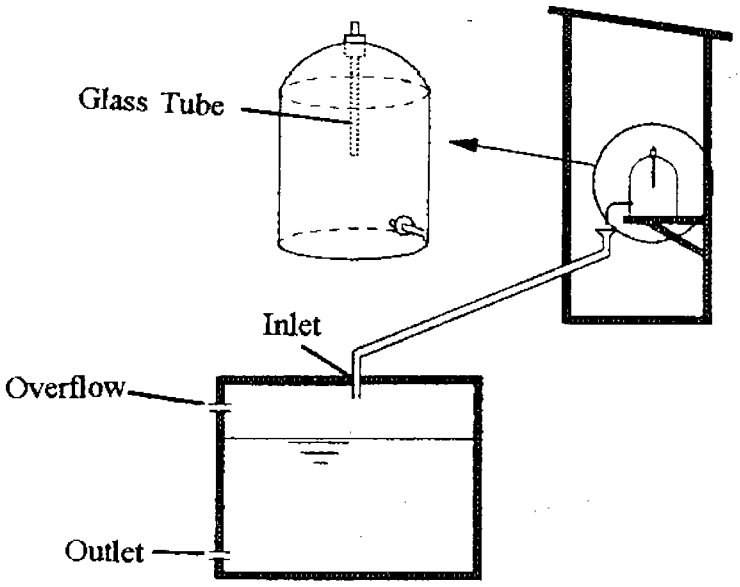

Figure 3. Constant - head aspirator

A plastic tube can be used to deliver hypochlorite to the dosing point, which should be above a point of turbulence. The tube should be laid with a continuous downward gradient to prevent choking and should run inside a metal tube if there is a risk of rodent attack.

Spare glass tubes should be kept on site, and rubber bungs should be changed every two years. The operator should understand the principle of the doser so that she or he will take the necessary care when recharging. The solution should be topped up to the foot of the neck and the bung pressed gently into position to avoid spillage. The foot of the centre tube should be repositioned if necessary. It may be necessary to remove sediment periodically, to avoid blockage of the capillary. The aspirator must then be rinsed with scrupulous care.

After recharging, the capillary should be set to the vertical position and left to drip until the centre tube becomes full of air and bubbles into the aspirator. The capillary should then be rotated into the position to give the required dose rate, which should be checked.

Gravity solution feeder

This is a proprietary design, available in a range of sizes. The principle is similar to the floating draw-off system, except that the constant head is maintained in a second tank by a ball valve.

Solutions can be dosed at rates from 22 litres to 44 cubic metres per day. A gravity solution feeder is shown in Figure 4.

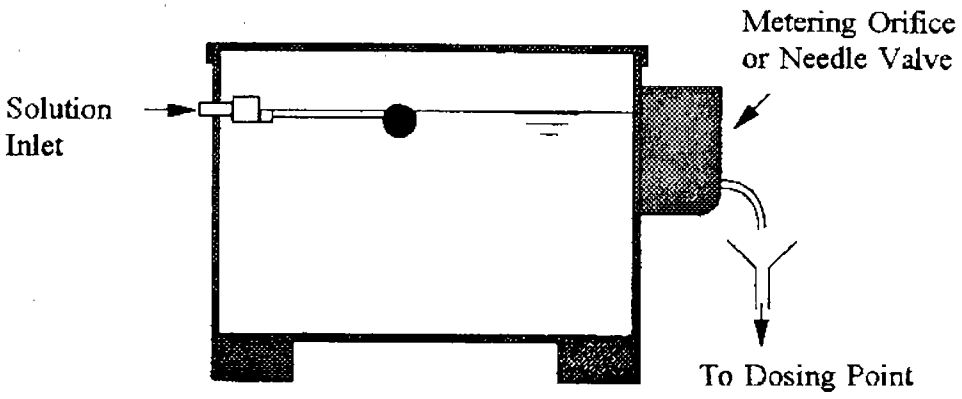

Figure 4. Gravity solution feeder

Venturi systems

Provided adequate hydraulic head is available, then the suction generated by a venturi (essentially a contraction in a pipe through which water flows) can be used to draw hypochlorite solution into a flow of water. Flow rate will be related to the head through which the solution must be drawn, so a constant head tank will be required. An illustration of this system is shown in Figure 5.

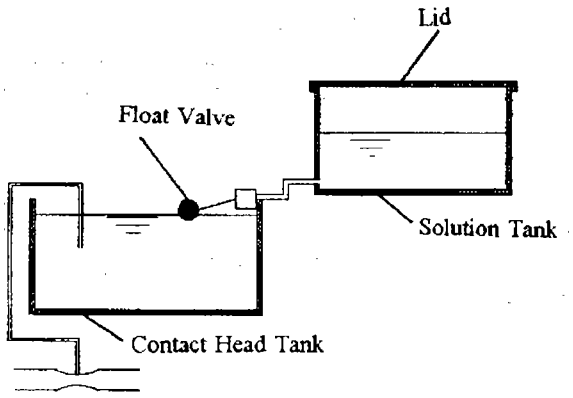

Figure 5. Venturi doser

Dosing pumps

A variety of dosing pumps exist, including self powered, water-powered, diaphragm displacement and electrical dosing pumps.

All hydraulic pumps require an adequate head of water with which to operate. The manufacturer's instructions for installation should always be followed. While some pumps are specifically designed for dosing of disinfectant solutions, others have been designed primarily for other purposes. Some, for example, are primarily designed for dosing agricultural chemicals into irrigation water.

Several types of electrical pumps are available and may be either mains or battery operated. Under some circumstances, battery operation from batteries recharged from a solar, wind or water powered generator may be preferred.

Reciprocating pumps are the most commonly used pumps for chemical dosing. They should be constructed from corrosion-resistant material. They can be of a piston or diaphragm type and can have both manual and automatic adjustment of stroke length and rate. The stroke length of the pump controls the dosing level and the stroke rate the dosing rate.

All dosing pumps require the following conditions to function properly :

- They should be sited in an accessible place with space and light for attention and repair.
- They should be securely mounted, and have short and direct runs.

- They should receive regular maintenance checks, and repairs should be made when necessary.
- A sufficient stock of essential spares should be held.
- There should be a properly trained and supported operator.

Some key factors influencing the use of dosing pumps are the following :

- Equipment should, if possible, dose the chemical as delivered. Dosing range is from about 1 ml/h to 5 l/h, although it should not be expected that any single unit would cover the whole range.

- Electrical supply voltage and frequencies vary from country to country, and pump motors must comply with local requirements. Units are also available which are designed to operate from 12V DC batteries.

- Preferred units should have : simple operating principles, simple and robust construction of liquid contact parts, few and slow-moving working parts, minimal sliding friction, positive mechanical drive (for example, crank) to the displacer, diaphragm-sealed pumping chamber, small unswept volume, two vertical-flow valves in series on both suction and delivery, ball valves on soft seats, access to valves without opening pumping chamber, design that provides ease of cleaning and replacement of renewable parts, adequate technical information, good after-sales service, ease of replacement, spare parts or similar units readily available.

- Adjustment of effective stroke length is acceptable from full stroke down to 25 per cent. Control of stroke rate is acceptable from 1 to 150 strokes per minute.
- Preference should be given to systems in which the hypochlorite solution container operates at pipeline pressure, provided that it can be refilled easily and that there is clear visual indication of the amount of hypochlorite remaining in stock.